

DEFENSE HEALTH PROGRAM (DHP)
16.A Small Business Technology Transfer (STTR) Program
Proposal Submission Instructions

The DHP STTR Program seeks small businesses with strong research and development capabilities to pursue and commercialize medical technologies.

The STTR Program Management Office (PMO), located at the United States Medical Research Materiel Command (USAMRMC), manages the DHP STTR Program. The DHP STTR Program harnesses the collective knowledge and experience of scientists and engineers, to identify and put forward research and development (R&D) topics to stimulate a partnership of ideas and technologies between innovative small business concerns (SBCs) and research institutions (RIs) through Federally-funded R&D to address DHP needs.

Solicitation, topic, and general questions regarding the STTR Program should be addressed according to the DoD Program Solicitation. For technical questions about the topic during the pre-release period, contact the Topic Authors listed for each topic in the Solicitation. To obtain answers to technical questions during the formal Solicitation period, visit <https://sbir.defensebusiness.org/sitis>. Specific questions pertaining to the DHP STTR Program should be submitted to:

DHP STTR Program Management Office (PMO)
usarmy.detrick.medcom-usamrmc.mbx.dhpsbir@mail.mil
(301) 619-5047

PHASE I PROPOSAL GUIDELINES

Phase I proposals should address the feasibility of a solution to the topic. Due to limited funding, the DHP STTR Program reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The DHP reserves the right to not fund a topic for any reason. Phase I contracts are limited to a maximum of \$150,000 over a period not to exceed six months. Awards will be made on the basis of technical evaluations using the criteria described in this DoD solicitation (see section 6.0) and availability of DHP STTR funds.

The DoD SBIR/STTR Proposal Submission system (<https://sbir.defensebusiness.org/>) provides instruction and a tutorial for preparation and submission of your proposal. Refer to section 5.0 at the front of this solicitation for detailed instructions on Phase I proposal format. You must include a Company Commercialization Report (CCR) as part of each proposal you submit. If you have not updated your commercialization information in the past year, or need to review a copy of your report, visit the DoD SBIR/STTR Proposal Submission site. Please note that improper handling of the CCR may have a direct impact on the review and evaluation of the proposal (refer to section 5.4.e of the DoD Solicitation).

Proposals addressing the topics will be accepted for consideration if received no later **6:00 a.m. ET, Wednesday, 17 February 2016**. The DHP requires your entire proposal to be submitted electronically through the DoD-wide SBIR/STTR Proposal Submission Web site (<https://sbir.defensebusiness.org/>). A hardcopy is NOT required and will not be accepted. Hand or electronic signature on the proposal is also NOT required. DHP has established a **20-page limitation** for Technical Volumes submitted in response to its topics. This does not include the Proposal Cover Sheets (pages 1 and 2, added electronically by the DoD submission site), the Cost Volume, or the CCR. The Technical Volume includes, but is not limited to: table of contents, pages left blank, references and letters of support, appendices, key personnel

biographical information, and all attachments. The DHP requires that small businesses complete the Cost Volume form on the DoD Submission site versus submitting it within the body of the uploaded Technical Volume. Proposals are required to be submitted in Portable Document Format (PDF), and it is the responsibility of submitters to ensure any PDF conversion is accurate and does not cause the Technical Volume portion of the proposal to exceed the 20-page limit. Any pages submitted beyond the 20-page limit will not be read or evaluated. If you experience problems uploading a proposal, call the DoD SBIR/STTR Help Desk 1-800-348-0787 (9:00 am to 6:00 pm ET).

If a small business concern is selected for an STTR award they must negotiate a written agreement between the small business and their selected research institution that allocates intellectual property rights and rights to carry out follow-on research, development, or commercialization (section 10).

PHASE II PROPOSAL GUIDELINES

Phase II is the demonstration of the technology found feasible in Phase I. Only Phase I awardees are eligible to submit a Phase II proposal. All Phase I awardees will be allowed to submit a Phase II proposal for evaluation and possible selection.

The details on the due date, content, and submission requirements of the Phase II proposal will be provided by the DHP STTR Program Office either during the Phase I award or by subsequent notification.

Phase II proposals will be reviewed for overall merit based upon the criteria in section 8.0 of this solicitation. STTR Phase II proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a **40-page** limit including: table of contents, pages intentionally left blank, technical references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any attachments. However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in others sections of the proposal submission as these will count toward the 40-page limit. ONLY the electronically generated Cover Sheets, Cost Volume and CCR are **excluded** from the 40-page limit. As instructed in section 5.4.e of the DoD Program Solicitation, the CCR is generated by the submission website based on information provided by you through the “Company Commercialization Report” tool.

Technical Volumes that exceed the 40-page limit will be reviewed only to the last word on the 40th page. Information beyond the 40th page will not be reviewed or considered in evaluating the offeror’s proposal. To the extent that mandatory technical content is not contained in the first 40 pages of the proposal, the evaluator may deem the proposal as non-responsive and score it accordingly.

Small businesses submitting a proposal are also required to develop and submit a technology transition and commercialization plan describing feasible approaches for transitioning and/or commercializing the developed technology in their Phase II proposal.

DHP Phase II Cost Volumes must contain a budget for the entire 24 month Phase II period not to exceed the maximum dollar amount of \$1,000,000. These costs must be submitted using the Cost Volume format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Volume Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. Phase II projects will be evaluated after the base year prior to extending funding for the option year. Phase II proposals should be structured as follows: the first 10-12 months (base effort) should be approximately \$500,000; the second 10-12 months of funding should also be approximately \$500,000. The entire Phase II effort should not exceed \$1,000,000. The Phase II contract structure is at

the discretion of the DHP's Contracting Officer, and the PMO reserves the option to reduce an annual budget request > \$500,000 if program funds are unavailable.

DISCRETIONARY TECHNICAL ASSISTANCE (DTA)

In accordance with section 9(q) of the Small Business Act (15 U.S.C. 638(q)), the DHP STTR Program will provide technical assistance services to small businesses engaged in STTR projects through a network of scientists and engineers engaged in a wide range of technologies. The objective of this effort is to increase DHP STTR technology transition and commercialization success thereby accelerating the fielding of capabilities to Soldiers, Sailors, Airmen and Marines, and to benefit the nation through stimulated technological innovation, improved manufacturing capability, and increased competition, productivity, and economic growth.

RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

The DHP STTR program discourages offerors from proposing to conduct Human Subject or Animal research during Phase I due to the significant lead time required to prepare regulatory documentation and secure approval, which will significantly delay the performance of the Phase I award.

The offeror is expressly forbidden to use or subcontract for the use of laboratory animals in any manner without the express written approval of the US Army Medical Research and Material Command's (USAMRMC), Animal Care and Use Review Office (ACURO). Written authorization to begin research under the applicable protocol(s) proposed for this award will be issued in the form of an approval letter from the USAMRMC ACURO to the recipient.

Furthermore, modifications to already approved protocols require approval by ACURO prior to implementation.

Research under this award involving the use of human subjects, to include the use of human anatomical substances or human data, shall not begin until the USAMRMC's Office of Research Protections (ORP) provides authorization that the research protocol may proceed. Written approval to begin research protocol will be issued from the USAMRMC ORP, under separate notification to the recipient. Written approval from the USAMRMC ORP is also required for any subrecipient that will use funds from this award to conduct research involving human subjects.

Research involving human subjects shall be conducted in accordance with the protocol submitted to and approved by the USAMRMC ORP. Non-compliance with any provision may result in withholding of funds and or termination of the award.

FOREIGN NATIONALS

If the offeror proposes to use a foreign national(s) [any person who is NOT a citizen or national of the United States, a lawful permanent resident, or a protected individual as defined by 8 U.S.C. 1324b (a)(3) – refer to Section 3.5 of this solicitation for definitions of “lawful permanent resident” and “protected individual”] as key personnel, they must be clearly identified. For foreign nationals, you must provide country of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. Please ensure no designated Privacy Act information is included in this submittal.

PUBLIC RELEASE OF AWARD INFORMATION

If your proposal is selected for award, the technical abstract and discussion of anticipated benefits will be publicly released via the Internet. Therefore, do not include proprietary or classified information in these sections.

NOTIFICATION SCHEDULE OF PROPOSAL STATUS AND DEBRIEFS

Once the selection process is complete, the DHP STTR Program Manager will send an email to the individual listed as the “Corporate Official” on the Proposal Coversheet with an attached letter of selection or non-selection. The notification letter referenced above will provide instructions for requesting a proposal debriefing. Small Businesses will receive a notification for each proposal that they submitted. The DHP STTR Program Manager will provide *written* debriefings upon request to offerors in accordance with Federal Acquisition Regulation (FAR) Subpart 15.5. Please read each notification carefully and note the proposal number and topic number referenced.

DHP STTR 16.A Topic Index

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| DHP16A-001 | Bio-mathematical Models of Aggregated Tissues & Organ Properties |
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DHP STTR 16.A Topic Descriptions

DHP16A-001 TITLE: Bio-mathematical Models of Aggregated Tissues & Organ Properties

TECHNOLOGY AREA(S): Biomedical

OBJECTIVE: To develop a preliminary framework for a bio mathematical model to explain how human tissues interact / behave at their boundaries; develop a mathematical framework for translating this tissue interaction / behavior into predictive mathematical / biomechanical models able to represent tissue property transitions (e.g. muscle to tendon/ligament), aggregated tissues (connective, epithelial, muscular, and nervous), and systems of tissues/organ properties and behaviors. Demonstrate how this proposed work product is scalable and flexible and can be augmented for future use in medical simulation applications. The long term goal of this effort is to create a high fidelity, validated, reliable, robust, and reproducible simulated tissue interaction model for used by the medical research, development, and training community in products such as virtual reality part task trainers, interventional simulation systems, and to inform research and development of other dynamic interactive anatomical models.

DESCRIPTION: Patients demand that their healthcare providers appropriately and accurately diagnose and treat their ailments. To address this level of diagnosis and treatment, medical simulation researchers and developers must continue to advance training and education products by designing improved fidelity simulated tissues. However, incomplete information about human tissue properties and unrealistic simulated tissue behavior have been identified as knowledge and technology gaps by both civilian and military leaders; in addition, some inaccurate properties and behaviors may even have an adverse impact on medical training outcomes. Tissue interaction properties (e.g. tensile, shear, friction, and so forth) of connective, epithelial, muscular, and nervous tissue including sub-components of each of these broad categories lack fidelity in current simulation systems. While some basic tissue properties are known, the breadth and quantity of data remains insufficient for the development of mathematical models able to produce the life-like interactions of aggregated tissues and human organs for use in medical simulation and training systems.

With the advent of open-source frameworks for medical simulation and other computational methods for mechanistic mathematical modeling of biological interfaces at the cellular scale, emphasis on multi-scale modeling methods in biological and medical applications, and recent work in assessing medical simulation deformable models now is the time to begin developing a new or improved integrated multi-scale biophysical mathematical medical models to represent the interactions of aggregated tissues and organs for implementation in medical simulation systems; especially to support virtual and augmented reality applications.

These biophysical mathematical models could then be used for virtual reality, manikin-based, and/or hybrid medical simulation systems. This research and development effort aims to enable future military healthcare personnel to practice the skills and procedures needed to provide safe and effective care prior to practicing on humans. Inputs to considered for inclusion but are not limited to biomechanical engineering, physiology, computational mathematics, mathematical modeling, and clinical research, in order to (1) define, describe, and validate tissue interaction properties and characteristics such as friction, elasticity, cut strength, tensile strength, shear force, torque / torsion, hydration, dielectric properties, and thermal properties in reticular connective tissue, adipose tissue, cartilage, bone, fascia, blood, epithelium, stratified epithelium, striated, smooth and cardiac skeletal tissue, and peripheral nervous tissues; and (2) formulate and create a mathematical framework based upon the biophysical properties which balance individual components as they relate to aggregated tissues/organs; and (3) demonstrate the viability of the framework for developing a comprehensive, aggregated tissue and organ model. These capabilities should be as open source as possible, require a low / no manpower footprint, and be a tool that can be self-sustaining and extensible for wide variety of military and civilian uses.

PHASE I: Required Phase I proof of concept and report will include:

- Provide a detailed description of the preliminary algorithm(s) and method(s) used to calculate the forces of interaction (anatomy/anatomy or tool/anatomy forces of interaction);
- Define and describe tissue interaction properties and characteristics: for example, but not limited to the following, frictional forces, shear and tensile forces, adherence, the effect of hydration, temperature, electrolytes, and inflammation;

- Provide references of all external data used and analyzed information of internally driven data;
- Provide a preliminary plan describing the methodologies to be used to validate the biophysical mathematical model;
- Provide information in the Phase I final report that described known gaps or inconsistencies in the proposed bio mathematical model, which would increase the risk to any extension of this work to Phase II.

PHASE II: At the end of Phase II, it is expected that prototype system be demonstrated. Tissue interaction model should be demonstrated through the use of an interactive software application. To provide a basis for future expansion, Phase II development should focus on the modeling dissection and exploration of vessels (artery and veins) such at the iliac, femoral, brachial, or carotid sites. Use of an accurately simulated dissecting tool (such as a Maryland dissector / curved dissector) to interact with the modeled tissues is desired within the interactive software application. It is intended that further development would be able to leverage the existing biophysical mathematical model for military injury point of care or civilian trauma surgery use cases. Additional deliverables include, but not limited to:

- Demonstrate the mathematical / biophysical tissue model based upon the appropriate tissue properties into an integrated prototype;
 - During Phase II an In Progress Review may be conducted in the Washington DC, northern VA, and Maryland area. Attendance could be in person or via tele/video-conference and is usually held during the 2nd year of Phase II.
- Documentation / reports detailing the integrated biophysical mathematical model. Plans for additional development are required for completion of the advanced prototype system;
- Detailed documentation / report describing the open-source components (if any) of the proposed system;
- Detailed documentation / report of the tissue interaction property / characteristic data and information that was used to create the model;
- Provide in a document / report any and all required software dependencies and minimum computer hardware specifications required to run the partially integrated biophysical mathematical model;
- Provide in a document / report any and all preliminary pilot data / information used to validate / verify predicted outcomes of the model. Provide the conditions and variables under which the tests were performed including preliminary data analysis and descriptions of known short-comings and provide plans for future mitigation / correction;
- Provide in a document / report human subject, animal, or cadaver approvals that were performed during the research such as acquisition of data / information to create the model or during the pilot test study; &
- If included, video appendices must comply with the following specifications:
 - Maximum run length: ≤ 6 minutes
 - Audio codec: AAC
 - Sample audio bit rate: 64 kbit/s (mono acceptable)
 - Video codec: H.264
 - Format: MPEG-4 (mp4) container
 - Accepted formats: (mov, avi, mpg, mpeg, mp4, wmv)

PHASE III DUAL USE APPLICATIONS: It is anticipated by the end of Phase III, that a transition ready biophysical mathematical tissue interaction model is made available. Provide in a document / report the probable life cycle management of such a fully integrated biophysical mathematical model including probable updates, maintenance costs, service related costs, and warranties. Provide anticipated cost per unit. The Phase III must provide documentation and reports of the "end-state" of the research. There must be at least one description of military applications and detailed plans must be provided in form of documents to fully explain the remaining research needed to that of an operational capability. Commercial applications OR one or more commercial technologies that could be potentially inserted into defense systems as a result of this research and development must also be proposed in the form of a document or report. Test and evaluation results of studies must be provided in a document or report (as well as the conditions under which the tests were conducted).

REFERENCES:

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3. Causin, P.; Sacco, R.; Verri, M.; A multiscale approach in the computational modeling of the biophysical environment in artificial cartilage tissue regeneration. *Biomech Model Mechanobiol* (2013) 12:763–780
4. Ambrosi, D.; Garikipati, K.; Kuhl, E.; Mini-Workshop: The mathematics of growth & remodelling of soft biological tissues. MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH; August 31st – September 6th, 2008
5. Edwards, C.; Marks, R.; Evaluation of Biomechanical Properties of Human Skin. *Clinics in Dermatology*; 1995;13:375-380
6. Marchal, M.; Allard, J.; Duriez, C.; Cotin, S.; Towards a Framework for Assessing Deformable Models in Medical Simulation. *ISBMS '08 Proceedings of the 4th international symposium on Biomedical Simulation*. Pages 176 – 184
7. McKee, C.; Last, J.; Russell, P.; Murphy, C.; Indentation Versus Tensile Measurements of Young's Modulus for Soft Biological Tissues. *TISSUE ENGINEERING: Part B*; Volume 17, Number 3, 2011

KEYWORDS: Medical modeling; computational modeling; tissue interaction; aggregated tissues; multi-scale modeling; virtual reality; augmented reality; biomechanical simulation; deformable models